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ABSTRACT

In a series of four interrelated reports, Rand work to date for the Air Force on the development of methodologies for designing programs of instruction is reported. This report, the third of the series, presents and discusses the use of a questionnaire that help curriculum designers to analyze a course of study to gauge its requirements for communication media, personnel, and time. Use of the questionnaire fits as a middle step in the larger sequence of MODIA (A Method of Designing Instructional Alternatives). The questionnaire causes the designer to subdivide each course into basic "learning events" and proceed through the branching questionnaire for each. (Author/RH)

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The MODIA Questionnaire for Curriculum Analysis

Rudy Bretz

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

Rand
SANTA MONICA, CA. 90406

TELECOMMUNICATION	Sound	Picture	Line Graphic	Print	Motion	RECORDING
CLASS I: AUDIO-MOTION-VISUAL						
	X	X	X	X	X	Sound film
Television	X	X	X	X	X	Video tape / Film TV recording
	X	X	X	X	X	Holographic recording
Video-phone	X	X	X	X	X	
CLASS II: AUDIO-STILL-VISUAL						
Slow-scan TV / Time-shared TV	X	X	X	X		Recorded still TV
	X	X	X	X		Sound filmstrip
	X	X	X	X		Sound slide-set
	X	X	X	X		Sound-on-slide
	X	X	X	X		Sound page
	X	X	X	X		Talking book
CLASS III: AUDIO-SEMIMOTION						
Telewriting	X		X	X	X	Recorded telewriting
	X		X	X	X	Audio pointer
CLASS IV: MOTION-VISUAL						
		X	X	X	X	Silent film
CLASS V: STILL-VISUAL						
Facsimile		X	X	X		Printed page
		X	X	X		Filmstrip
		X	X	X		Picture set
		X	X	X		Microform
		X	X	X		Video file
CLASS VI: SEMIMOTION						
Telautograph			X	X	X	
CLASS VII: AUDIO						
Telephone / Radio	X					Audio disc / Audio tape
CLASS VIII: PRINT						
Teletype				X		Punched paper tape

The Communication Media

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PREFACE

This is one of four interrelated reports describing Rand work for the Air Force to date on the development of methodologies for designing programs of instruction. The reports in the series are:

R-1018-PR, *An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training,* Polly Carpenter.

R-1019-PR, *The MODIA Decision Process for Developing Strategies of Air Force Instruction,* Polly Carpenter and Barbara Horner.

R-1020-PR, *The MODIA Questionnaire for Curriculum Analysis,* Rudy Bretz.

R-1021-PR, *MODIA Applied in the Design and Cost Analysis of an Innovative Air Force Course,* Robert L. Petruschell and Polly Carpenter.

The first of these provides an overview of the methodologies being developed; the second and third describe some of the major analytical tools used to provide inputs to the design process; and the last sets forth the results of a completed design cycle, parts of which were carried out manually, applied to a specific course in Air Force technical training.

This work has been conducted under a Rand project entitled *Analysis of Systems for Air Force Education and Training.* Emphasis has been on the use of technology in designing instruction for formal technical training or for higher education, as at the Air Force Academy. The results will support the activities of the Director of Personnel Plans, Headquarters USAF; DCS/Technical Training and the Training Development Directorate, Headquarters Air Training Command; and the Air Force Human Resources Laboratory, especially the Technical Training and Professional Education divisions. It will be of particular interest to those working on the Advanced Instructional System.

This report is part of a continuing Rand effort to apply systematic methods of analysis and synthesis to issues and problems in education and training. Related studies have concerned Air Force pilot training and management of the pilot force, evaluation of programs of compensatory education, design of information systems for local school districts, and other diverse concerns. A special bibliography of Rand work in education is available on request.

3-2-73

ERRATUM

R-1020-PR THE MODIA QUESTIONNAIRE FOR CURRICULUM ANALYSIS, Rudy Bretz, November 1972, Unclassified

The Professional Education Division of the Air Force Human Resources Laboratory, mentioned in the Preface, was disbanded in July 1972 and no longer exists as an organizational unit.

SUMMARY

This is one of four reports describing Rand work for the Air Force on the development of methods for designing programs of instruction, particularly for technical training and higher education. The first report in the series gives an overview of Rand's comprehensive, semiautomated method, called MODIA (A Method of Designing Instructional Alternatives).[1] The second and third in the series describe some of the major analytical tools in the MODIA process; and the fourth gives the results of a sample design cycle, completed for a specific course in Air Force technical training.

This is the third report in the series. It presents, and discusses the use of, a questionnaire that helps the designer of a curriculum analyze a course of study to gauge its requirements for communication media, personnel, and time. Use of the Curriculum Analysis Questionnaire (CAQ) figures as a middle step in MODIA, which involves the following procedures:

Step 1. Analyze the learner population.
Step 2. State the policy (objectives) of the educational institution.
Step 3a. Analyze the curriculum (by means of the CAQ).
Step 3b. Specify the instructional strategy (computer-assisted).
Step 4. Specify the design criteria.
Step 5. Describe the rate of student entry and the institution's resources and constraints.
Step 6. Produce an instructional design alternative (computer-automated).
Step 7. Produce a cost and resource analysis (computer-automated).
Step 8. As necessary, depending on the acceptability of the outputs, repeat any of steps 1-7 with different inputs until the most desirable system emerges.

Curriculum analysis by means of the CAQ works by causing the user of the questionnaire (the designer, who has already established his curriculum and knows

[1] For the rationale and general description of the procedures and tools involved in MODIA, see Polly Carpenter, *An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training*, The Rand Corporation, R-1018-PR, November 1972.

what is to be taught) to subdivide each course into basic "learning events," units of homogeneous instruction, and to proceed through the CAQ for each one. Since the CAQ is structured as a branching questionnaire, the user encounters only those questions that are relevant to the particular type of instruction that the learning event represents. The user is led to specify characteristics such as the learning event's requirements for personnel and facilities, and its learning objectives and appropriate means of diagnosing their attainment (e.g., multiple-choice questions, or a student performance or product).

Each learning event is classified in one of twelve instructional categories falling in three general types of instruction. Type I instruction refers solely to the presentation of information and requires no drill or practice; Type II instruction requires drill or practice (either cognitive or psychomotor) but can be done in a classroom or carrel without special facilities; and Type III instruction requires special equipment or facilities, such as a laboratory or workshop.

Besides analyzing the learning events in his course in increasing detail as he proceeds through the CAQ, the designer discovers which learning events could benefit from communication media and what classes of media are appropriate to them. (Whether or not he chooses to use media at all for any learning event is a decision that comes later in the process of instructional design.)

To illustrate how the CAQ guides the designer in the choice of communication media, questions following the logic of a simple decision tree ask the designer whether the subject to be taught in the learning event is abstract or concrete, and if concrete, whether it requires visual or audial (auditory) presentation, or both. The CAQ guides the user to the simplest appropriate communication media. For example, if a subject does not require audial presentation, the expensive audio-motion-visual media (e.g., television) are eliminated; if it does not need to be seen in motion, the motion-visual medium, silent film, is also eliminated; the final appropriate media class is thus the still-visual (e.g., the printed page).

It should be noted that the CAQ indicates communication options by *class* of media, according to a taxonomy developed by the author (see inside front cover). The final choice of media to be used in a course should specify a particular medium (e.g., film, video tape, live television), submedium (e.g., 16-mm, 8-mm, 2-in. video tape, 1-in. tape), mode (group or individual presentation), and response or feedback system required. Details of the most practicable media system will emerge from step 6 of the MODIA process, after the institution's instructional criteria and its resources and constraints have been taken into account.

It is intended that the CAQ be tested in real-world course design. The final version that emerges, though an integral part of the semiautomated MODIA process will be able to be used, independently, in a purely manual process of instructional design. In either case the CAQ is used manually. The information elicited by the CAQ is needed for designing an instructional system, regardless of the method being followed. With a few additional questions, the CAQ can provide even the planner of a traditional instructional system with a convenient means of analyzing his instructional needs.

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I. INTRODUCTION

Since 1968, Rand has been working on the design of instructional programs to help the Air Force, especially the Air Training Command (ATC), determine systematically the mix of instructors, facilities, materials, and students that should go into its training and other instructional programs. As a result of that work, Rand has developed MODIA, a comprehensive methodology for designing an instructional program. MODIA (A Method of Designing Instructional Alternatives) consists of a sequence of procedures and semiautomated "tools," some of which have already been designed and are described in other reports in this series.[2]

Figure 1 illustrates the steps in the MODIA process. As it shows, the process is intended to produce precise guidelines about how long a course should be, the number of students who should constitute a class, and what facilities, equipment, personnel, and dollars are needed, and when. By means of MODIA, planners should be able to design an instructional program efficiently and with confidence both that the guidelines are acceptable to the teaching institution and that the methods of teaching the course are appropriate to the learners. The steps are briefly described below.

Step 1: *Analyze the learner population* in terms that will affect the way the course is taught (e.g., will some students be more familiar than others with the subject matter?).

Step 2: *State the institution's policy* by means of a short questionnaire,[3] which elicits information on the institution's goals, the extent to which it can adjust to variations in the student population, and how it relates to the institutions that supply its students and to those that use its graduates.

Step 3a: *Analyze the curriculum* by means of the CAQ, a branching questionnaire that helps the user describe his course of study in detail. It elicits a description of each **learning event**[4] in the course of study in terms that help determine require-

[2] See the list in the Preface.

[3] Polly Carpenter and Barbara Horner, *The MODIA Decision Process for Developing Strategies of Air Force Instruction*, The Rand Corporation, R-1019-PR, November 1972.

[4] See Glossary. Throughout, terms listed in the Glossary appear in boldface type the first time they are used.

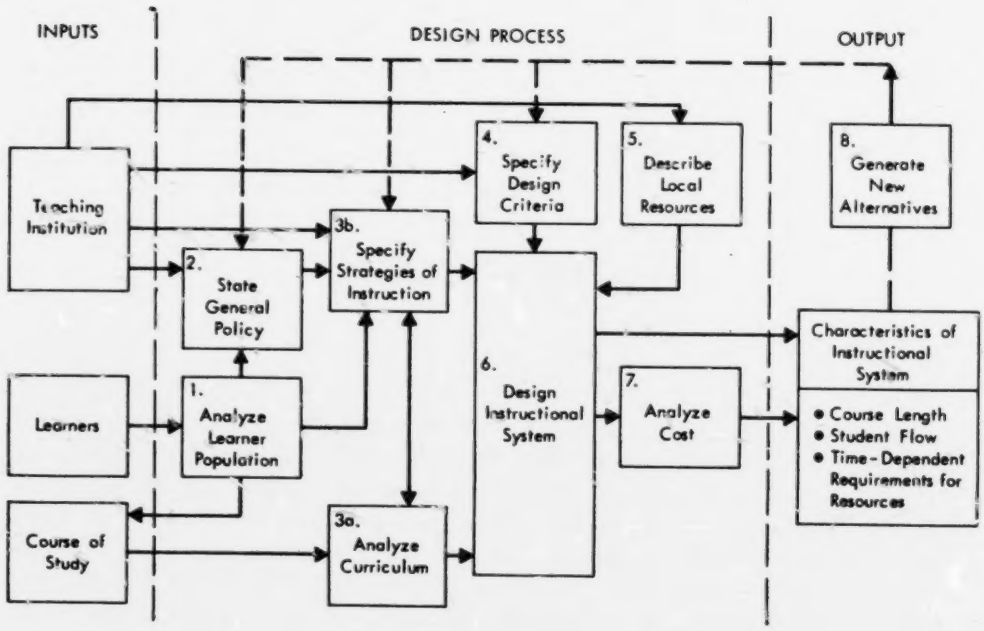

Fig. 1—The MODIA process

ments for personnel, communication media, and other appropriate resources. The CAQ is structured so that for each learning event the designer encounters only questions that are relevant to the event's particular type of instruction. After the designer has gone through the CAQ for each learning event, he is prepared for step 3b, where specifications of instructional method are explicitly entered into the design process.

Step 3b: *Specify strategies of instruction* by means of a logic tree, with each decision point a logical consequence of the preceding decisions.[5] This step employs DISTAF, an interactive computer program written for use on JOSS[6] that is being translated into Interactive Fortran. Its user's manual presents the pros and cons of the decisions to be made at each point, along with some of the logical consequences of each choice. DISTAF permits the designer to formulate dozens of different teaching strategies for a single course. As defined here, "instructional strategy" has two basic dimensions. For each type of instruction (identified in the CAQ), the designer specifies *what* the teaching agent will be and *how* students will interact with the agent.

Step 4: *Specify and rank design criteria,* representing the institution's instruc-

[5] Carpenter and Horner, op. cit.

[6] Rand's on-line, interactive computer system.

tional desiderata, such as least cost, shortest course length, graduation of the most students per unit of time, and maximum use of communication media.

Step 5: *Describe local resources,* information on the rate of student entry and the school's resources and constraints, to be gathered by means of a logically structured set of questions. Data include number of available classrooms, laboratories, and other facilities; the availability of communication equipment; and the geographic distribution of students. The resulting description is used in step 6 to determine class size, to select specific communication media, and to serve other purposes.

Step 6: *Produce an instructional system.* The final design will incorporate as direct inputs the curriculum-analysis data, the instructional strategies, the design criteria, and the description of local resources. First, each learning event is linked to the instructional strategy chosen for its particular category of instruction. Second, student flow through the course is simulated by a flow and scheduling model to derive graduation rates and resource requirements. Third, specific personnel, communication media, and facilities are selected.

Step 7; *Analyze the costs* and resources of the system.

Step 8: As necessary, depending on the acceptability of the outputs, *repeat any of steps 1-7* with different inputs until the most desirable system emerges.

This report describes a key element in the MODIA process (though it can be used separately)—the Curriculum Analysis Questionnaire (CAQ). Used as part of MODIA, it comes into play in step 3a (see Fig. 1). Whether incorporated in MODIA or separate, however, the CAQ is intended for use by an instructional designer or planner when he knows *what* the substance of the proposed course will be and *who* will take the course, and must decide *how* to teach it.

The "how" that the CAQ particularly addresses is the use of communication media in the course. Communication media have become increasingly important in instruction, but many course designers are not familiar with their use. The CAQ provides guidance on whether communication media are appropriate at all for a given course, and if so, what kind. It should be noted that that guidance is limited to those communication media classes or specific media (according to the author's taxonomy reproduced inside the front cover) that are *appropriate* to the instructional need. Decisions about what specific media or submedia are *practicable* to use in a course are properly made later in the instructional design process, after inputs on resources and constraints have been entered into the process.

Section II discusses the rationale and features of the CAQ, and Sec. III reproduces and explains the text of the questionnaire. Section IV gives a hypothetical example of use of the CAQ to analyze a course in beginning photography. Then, in Sec. V, suggestions are given for field testing the CAQ with courses actually being designed.

II. WHAT THE QUESTIONNAIRE DOES

The Curriculum Analysis Questionnaire has two features new to instructional design. The first is a new taxonomy of instruction. The second is a logic process for selecting the simplest appropriate class of communication media according to the subject matter and the category of instruction in each learning event.

As with any tool, the success of the CAQ depends on the skill and judgment of the user. A brief glance at some of the questions reveals that the judgment of the user is especially important in answering the questions concerned with choosing **communication media**. Thus, the CAQ does not eliminate the need for a highly trained and experienced instructional designer who is thoroughly familiar with the resources and constraints of the teaching institution. The designer's background should include knowledge of conventional teaching methods and at least one communication medium.

ANALYZING INSTRUCTION

At the point in the development of an instructional system when the CAQ is used, the designer knows exactly *what* is to be taught but not *how* it should be taught. Instructional technology has provided many alternative methods by which the student can receive instruction. **Presentation** of theory can be made by an instructor in a classroom, by a projected film or video tape, or by an individual communication device, such as a film viewer or an audio cassette player. Likewise, the **performance model** (demonstration of a skill to be learned) can be presented to the student in many ways. Student **performance** can take place on a fully operating machine, on a functioning mock-up containing only the parts necessary to the immediate objective, or on a simulator.

Evaluation, like presentation, can be done many ways. Formal evaluation can be made directly by an instructor or indirectly by recording student performance for later assessment. If the evaluation need not be a formal measurement of achievement (e.g., an examination), it can be done by the student himself, by comparing a record of his performance with a model of the required standard.

The CAQ helps the instructional designer decide among these many options. First, he must divide his course into elemental units of instruction called learning events. For example, in a course designed to teach how to operate a machine, the first learning event might include the theory behind the equipment and the interrelationship of its parts; the names of the controls and how they are related to the functions they perform. That learning event could usually be accomplished in one classroom lecture or lecture-discussion. The next learning event in such a sequence might be a performance model, where the instructor would demonstrate the equipment in operation. The student would observe the procedure he would later follow the techniques it involves, and the criteria that define the performance expected of him. Normally, a third learning event would take place, of considerably longer duration, in which the student would take over the controls and practice using the equipment himself. That event might require the presence of an instructor to assess the student's performance or to prevent injury to the student or damage to the equipment.

The ultimate intent of identifying learning events is to estimate the kinds and amounts of resources that are needed to accomplish each part of a course of instruction. The term "learning event" refers only to basic instruction, not, for example, to **question-and-answer** or **review** sessions. The resource requirements for these noninstructional activities can be calculated by reference to the learning events on which they are based.

The instructional designer analyzes a course of study by answering the appropriate questions on the CAQ for each learning event, one event at a time. His responses, entered on a form and later transferred by a card-punch operator onto electronic data-processing cards, constitute the CAQ input to the MODIA system. Even if MODIA is not involved, standard data-processing procedures can be used to determine, for example, the total amount (i.e., for all learning events and instructional minutes) of each type of resource and the amount of program material required for each medium or class of communication media.

Because the purpose of curriculum analysis by means of the CAQ is the practical determination of resource requirements, rather than the theoretical classification and description of learning, existing systems for classifying instruction could not be used. That includes the conventional division of instruction into knowledge, skills, and attitudes, even in the form set forth in Bloom's *Taxonomy of Educational Objectives,* where the three divisions are called the **cognitive**, **psychomotor**, and **affective domains**.[7]

First, we had to distinguish between instruction that requires only the presentation of information (with or without student response) and training in skills, which requires **drill** or **practice**. The simplest classification systems fail to recognize that not all skills are motor or psychomotor; many are purely cognitive (e.g., computational skills, language vocabulary recall, skills of perception and recognition). Since our concern was with the need for resources, whether drill or practice is cognitive

[7] Benjamin S. Bloom et al., *Taxonomy of Educational Objectives: The Classification of Educational Goals,* New York, David McKay, 1956.

or psychomotor seemed less relevant than whether it can be done in a classroom or carrel, or whether it requires **special facilities** (e.g., parade ground, hangar, laboratory) or **special equipment** (e.g., musical instrument, a piece of machinery).

For the purposes of the CAQ, we divided instruction into three general types, which are in turn divided into categories (see Table 1). Type I covers instruction not requiring student performance (drill or practice). It refers to the simple presentation of facts and ideas for students to learn or be moved to (later) action by. This type of instruction may have affective goals. Students are expected to absorb Type I instruction, not to perform, beyond perhaps answering questions. Type II includes instruction in skills that the students are expected to master. It requires drill or practice in a classroom or carrel without special equipment or facilities. Type III instruction requires the students to learn skills that demand special equipment or facilities or both. The 12 subtypes, or categories, are important to the utility of the CAQ, and a key question asks the user to assign a number denoting category of instruction to each learning event.

Category 1 instruction represents the typical instance of knowledge or theory presentation, usually in the form of a classroom lecture. Category 2 instruction

Table 1

CLASSIFICATION OF INSTRUCTION IN THE CAQ

Type	Category
I • no student performance	1. Presentation not requiring special equipment or facilities 2. Presentation requiring special equipment or facilities
II • student performance • requires no special facilities or equipment--can be done in classroom or carrel	3. Pure performance, interactive skills 4. Pure performance, individual skills 5. Performance model, interactive skills 6. Performance model, individual skills 7. *Follow-me* (mixed demonstration and performance), individual skills
III • student performance • requires special facilities or equipment	8. Pure performance, interactive skills 9. Pure performance, individual skills 10. Performance model, interactive skills 11. Performance model, individual skills 12. Follow-me (mixed demonstration and performance), individual skills

requires special equipment or facilities for presentation, but does not include student performance. It may consist of the demonstration of phenomena or equipment. Category 1 and 2 instruction is entirely amenable to the use of communication media and associated response systems. Instruction of the following categories may use these media less extensively.

Category 3 instruction involves student performance of interactive skills, either simple or complex, that can be exercised in a classroom. Such skills include choral singing, dramatics and role-playing, and various instructional games. Category 4 refers to drill and practice in individual rather than interactive skills requiring no more special equipment than pencil and paper or small objects. Categories 3 and 4 are characterized as "pure performance" because no demonstration is involved. Categories 5 and 6 also refer to interactive and individual skills, respectively. However, they involve a performance model—demonstration only. Though they are intended to generate later student performance, performance is not an immediate part of these purely presentational categories. Category 7 includes instruction in which a performance is alternately demonstrated by an instructor and then performed by a learner, step by step. Categories 8 through 12 are similar to the preceding five categories but fall in Type III: instruction involving drill and practice but located elsewhere than a classroom or carrel.

Most of these 12 categories can be subdivided into simple and complex instruction and, further, into instruction in which student progress can be checked by **selected responses** (e.g., multiple-choice questions) and that requiring **constructed responses** (e.g., written, spoken, manipulative).

CHOOSING THE APPROPRIATE COMMUNICATION MEDIA

After the designer has specified the types of instruction in the learning events of the course he is analyzing, the CAQ helps him choose the simplest class of communication media appropriate for each event.[8] Decision tables in the CAQ ask a number of questions that are critical in the selection of communication media and give detailed criteria for their answers; the pattern of answers designates the appropriate media class. To illustrate, we find the following questions: "Are visual means required?" "Is sound required?" "Is motion required?" If the answer to all of them is "yes," class I, audio-motion-visual media, is indicated. The class indicated in the example just cited includes specific media such as sound film (in sizes ranging from Super-8 to 16-mm), presented on a large screen or an individual viewer; live television or video tape in a number of different formats; and the new video cassettes.

[8] For a more detailed discussion of the classification of communication media, see Rudy Bretz, *A Taxonomy of Communication Media*, Englewood Cliffs, N. J., Educational Technology Publications, 1971 (also available in soft cover to Air Force users as Rand R-697-NLM/PR). A basic discussion of the instructional uses of communication media is found in Rudy Bretz, *The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs*, The Rand Corporation, R-601-PR, February 1971.

To narrow the choice of communication medium, the decision tables are followed by other questions that ask the user to determine the level of visual and audio fidelity required if the instruction were to be done by communication media rather than face-to-face presentation. For example, the user is asked to state a learning event's needs for visual fidelity on three dimensions: color, range of gray tones, and degree of definition required. If he states that he must have full and realistic color, this requirement not only eliminates all black and white media but, in the case of class I media, most color television and video tape systems as well. Though the latter are capable of full color, it is not necessarily or consistently realistic color. If he indicates that black and white pictures would suffice, color systems are eliminated. (Black and white pictures can be carried over a color system, but the CAQ is designed to indicate the *simplest* appropriate medium.) However, if many learning events in the course require color, and only one calls for black and white, the color system alone would be indicated, since it would make little sense to use two separate systems.

Thus, the CAQ prepares the way for final instructional system design by suggesting one or more appropriate communication media for use in a course. The final selection of specific media is made later in the instructional design process, on the basis of available resources and existing constraints. If the MODIA methodology is being followed for the instructional design process, that decision occurs in step 6, at which point the choice of specific communication media for particular courses is almost automatic.

III. THE CURRICULUM ANALYSIS QUESTIONNAIRE

PRELIMINARIES

Before the CAQ is used, the following tasks should be completed.

1. The curriculum of the course should be planned with the objectives specified, preferably in behavioral terms.
2. The objectives should be in logical sequence.
3. The instruction should be divided into **topics** and the topics subdivided into learning events.
4. An approximate time should be allotted to each learning event.

Estimates may be based on previous experience with the course of study. Data are required only for true learning events. Time allotments should not include:

- Answering students' questions about previous instruction or discussing with students subject matter previously covered.[9]
- **Scoring deskwork** or homework in class.
- Reviewing previous instruction.
- Formal examinations of student achievement.
- **Housekeeping** (announcements, cleanup, etc.).
- Coffee breaks, transportation, etc.

Such activities are not considered part of the curriculum and do not require analysis. If the CAQ is used as part of MODIA, the resource requirements for those activities are automatically calculated on the basis of (1) the established instructional strategy and (2) the questionnaire data concerning the true learning events from which the foregoing noninstructional activities derive.

If the CAQ is used independently of MODIA, time and resources for noninstructional activities are determined similarly, with the designer taking his strategy and the original learning events into account.

[9] If the aim of a discussion session is to develop students' skills in conversation or group relationships, however, the discussion session should be considered a learning event.

The questionnaire is divided into three parts. Part I is intended to help the instructional designer specify his course in increasing method-related detail. Part II is intended to help him decide whether communication media are appropriate for any parts of it, and if so, which parts and what class of media. Part III is intended to help him define more precisely the specific communication media that are appropriate.

The questionnaire appears as three columns. The first column cues the user which questions to answer for each learning event. The second column contains the question proper and the various possible responses. The third column lists the code numbers for the answers, one of which should be entered on the response form for each question.

PART I

Answer for	Question	Code
k All events	Assign a topic number.	k = ___
j All events	Assign a learning event* number.	j = ___
1. All events	Estimate the number of minutes that would be required for the average student in your student population to achieve the objectives of this event, given conventional instructional methods* and no time spent waiting for facilities or equipment to become available?	x(1) = ___ min
2. All events	Estimate the number of minutes that would normally be devoted to housekeeping* activities for this event.	x(2) = ___ min
3. All events	Does the accomplishment of this task require the integration of several simpler concepts or skills?	
	Yes:	x(3) = 1
	No:	x(3) = 0
4. All events	Considering the capabilities of the average student in your learner population, how difficult is this event to master?	
	Relatively hard:	x(4) = 1
	Average or relatively easy:	x(4) = 0

*See Glossary for definition. An asterisk will be used throughout the questionnaire at the first mention of such terms to remind the user of their special meanings in this context.

Answer for	Question	Code
5. All events	Is this learning event intended to be encountered by all students?	
	If so, If not:	x(5) = 0
	It is intended for students who lack necessary prerequisites.	x(5) = 1
	It is intended to be skipped by students who have shown mastery of the subject matter.	x(5) = 2
	It is intended to be skipped by students who are not bright enough to grasp the subject matter in the allotted time.	x(5) = 3
	It is intended to be skipped by extremely bright students.	x(5) = 4
	It is intended as enrichment for students who finish other work easily and have additional time.	x(5) = 5
	It is intended as remedial instruction for students who have difficulty mastering the assigned subject matter.	x(5) = 6
6. All events	Indicate the learning event's category of instruction. [See Table 1.]	
	Type I (presentation only):	
	No special equipment or facilities required	x(6) = 1
	Special equipment or facilities required	x(6) = 2
	Type II (in classroom or carrel):	
	Performance of Interactive skills Individual skills	 x(6) = 3 x(6) = 4
	Performance model of Interactive skills Individual skills	 x(6) = 5 x(6) = 6
	Follow-me instruction (individual skills)	x(6) = 7
	Type III (requires special facilities):	
	Performance of Interactive skills Individual skills	 x(6) = 8 x(6) = 9
	Performance model of Interactive skills Individual skills	 x(6) = 10 x(6) = 11
	Follow-me instruction (individual skills)	x(6) = 12

	Answer for events for which x(6) =	Question	Code
7.	3,4,7,8,9, 12	Is the achievement of a minimum rate of performance (speed) an objective of this learning event?	
		Yes:	x(7) = 1
		No:	x(7) = 0
8.	3,5,8,10	In this event requiring interactive performance, how many are needed in the group?	x(8) = ___
9.	2,5,6,10,11	How many persons besides the instructor are required to produce the presentation, whether face-to-face or recorded? Enter number by level.	
		a. Instructor level	x(9a) = ___
		b. Student level	x(9b) = ___
10.	3,4,7,8,9, 12	Must an instructor be present to evaluate the student's performance and provide him with knowledge of results?	
		Yes:	x(10) = 1
		No:	x(10) = 0
11.	8,9,12	Must the student be supervised to prevent injury to himself, the equipment, or the facilities? If yes, by whom? (If x(10) = 1, enter 1.)	
		Not necessary	x(11) = 0
		Instructor	x(11) = 1
		Instructor aide	x(11) = 2
		Student monitor	x(11) = 3
12.	2,8,9,10, 11,12	What special area is required (for face-to-face presentation, student performance, or production of media materials)?	
		None	x(12) = 0
		A distant location	x(12) = 1
		Outside but near school	x(12) = 2
		Large laboratory, workshop, etc.	x(12) = 3
		Small laboratory	x(12) = 4
13.	3,4,8,9	Can student progress in mastering the skill in this event be adequately diagnosed by selected responses* (e.g., multiple-choice questions)?	
		Yes:	x(13) = 1
		No:	x(13) = 0
14.	3,4,8,9	Answer only if x(13) = 0. What constructed response* is required?	
		A simple verbal (written or spoken) expression	x(14) = 0

Answer for events for which x(6) =	Question	Code
	A student performance (including paper-and-pencil problem-solving)	x(14) = 1
	A student product (e.g., object, essay, photograph, film, tape, etc.)	x(14) = 2
15. 3,4,8,9	Answer only if x(13) = 0. What is the simplest appropriate means for recording the constructed responses required in this learning event?	
	Paper and pencil	x(15) = 1
	Keyboard and computer memory	x(15) = 2
	Audio tape	x(15) = 3
	Still photography	x(15) = 4
	Silent film	x(15) = 5
	Video tape (sound and picture)	x(15) = 6
	Other materials	x(15) = 7
16. 2,8,9,10,11, 12	Is equipment other than cameras, tape recorders, etc., required to make the presentation or for use in student performance?	
	Yes:	x(16) = 1
	No:	x(16) = 0
17. 2,8,9,10,11, 12	Answer only if x(16) = 1. Is the special equipment already on hand?	
	Yes:	x(17) = 1
	No:	x(17) = 0
18. 2,5,6,7,10, 11,12	If the presentation were given face-to-face with the usual instructional aids, how many people could see it at one time?	x(18) = ___
19. 1,2,4,5,6, 9,10,11	Estimate the length of time needed to make the presentation, give the demonstration, or specify problems and directions. This is meant to exclude time spent in class discussion, answering students' questions, student performance, and housekeeping. If presentation must be repeated, estimate time for first presentation only.	x(19) = ___ min

	Answer for events for which x(6) =	Question	Code
20.	3,4,7,8,9, 12	Are special materials required by students for use in performance?	
		Yes:	x(20) = 1
		No:	x(20) = 0
	Answer for		
21.	All events	Is this a scheduled or an unscheduled* learning event:	
		Scheduled:	x(21) = 1
		Unscheduled:	x(21) = 0
22.	All events	Will there be a subsequent formal evaluation of the student's mastery of the subject matter in this learning event?	
		Yes:	x(22) = 1
		No:	x(22) = 0
23.	All events	Estimate the number of months between revisions of the curriculum content of this learning event.	x(23) = ___ mo
24.	All events	Does this learning event contain classified information?	
		Yes:	x(24) = 1
		No:	x(24) = 0
25.	All events	Is this event at the end of a major section of the course?	
		Yes:	x(25) = 1
		No:	x(25) = 0
26.	All events	Answer if x(25) = 1. Estimate the percentage of students who will drop out or be eliminated from the course before the next learning event.	x(26) = ___ %
27.	All events	Answer if x(25) = 1. Estimate the percentage of students who will be washed back* to repeat the last major section.	x(27) = ___ %
28.	All events	Estimate the percentage of students who would normally need some remedial instruction after this learning event.	x(28) = ___ %

PART II

Part II of the CAQ, comprising the complex question 29, is intended to help the instructional designer determine which learning events in his course can benefit from communication media, and what classes of media are appropriate for them. It

does so by guiding him through two decision tables, A and B, which distinguish between subject matter in the "perceptual" and "conceptual" domains. These terms correspond approximately to "concrete" and "abstract," except that not everything that is perceived is generally considered concrete (e.g., optical phenomena, actions, and events).

The perceptual domain includes subjects that can be perceived and directly experienced through the senses (e.g., persons, places, and things). Realistic representation is often required for presentation of such subject matter, to give the learning greatest transfer value when the student experiences the subject in the real world. Thus, audial[10] or visual means or both are generally required of communication media to represent subjects in the perceptual domain. (If perception is required by senses other than sight and hearing, instructional aids may be used, but existing communication media will not be adequate since they involve only the two senses.)

The conceptual domain includes concepts, thoughts, and mathematical relations. Although presentation of information in that domain must generally be done with words or other symbols, it is often desirable to support the effect of words with print or picture. Evidence has shown, however, that for representing concepts, abstract depictions—stick figures, line drawings—are often more effective than realistic representations such as photographs.

By proceeding through Decision Tables A and B in question 29, the user is led to select the simplest appropriate class of communication media for the presentation of each learning event in his course. As noted above, the fact that a media class is designated does not necessarily mean that it will be used. That decision occurs later in the MODIA process.

At that later point, in determining the most practicable communication medium needed, the MODIA design process will raise the level of quality or capability above what the user specifies whenever possible. It will not lower it below the minimum the user indicates to be acceptable. Therefore, when making the decisions required in the tables, the user should specify only the capability or quality *required* (unless the questions ask for "desirable" capabilities). He should not ask for motion pictures, for example, if still pictures will achieve the objective, or for color images if black and white will do. Instructional designers often call for motion, color, high definition, and the like—even though they are not required for the specified objectives—with the intent of thereby changing students' attitudes. If such changes are desired, the statement of objectives of the learning event should be rewritten to include these affective goals.

Learning events that are pure performance (x(6) = 3, 4, 8, or 9) do not involve presentation and would seem not to need communication media. However, media might be useful for the communication of the necessary directions and stimuli for drill or practice. Against the possibility, then, that communication media will later be specified, the user should assign a class of communication media to learning

[10] The word "audial" is coined as the counterpart of "visual." The nearest existing words are "auditory" and "audio," but neither conveys the sense intended. "Auditory" implies a reference to the physiology of sound perception. "Audio" refers to physical sound or its reproduction, especially when translated into electrical signals. Neither is quite right for denoting a characteristic of program software.

Answer for

29. All events

DECISION TABLE A

Conditions: *Does this learning event require:*	Rules *(Read down.)*						
1. Visual means besides print?[a]	Y	Y	Y	Y	N	N	N
2. Sound?[b]	Y	Y	N	N	Y	N	N
3. Motion?[c]	Y	N	Y	N	-[d]	-	-
4. None of the above. Instead, perception through senses other than sight and hearing?[e]	-	-	-	-	-	N	Y
Actions:							
5. Simplest appropriate media class [x(29) =]	I	II	IV	V	VII		0[f]
6. Go to Decision Table B						x	

[a]Answer "Y" if:

- o Visual recognition or discrimination is an objective of the learning event.
- o A process or procedure is to be presented or demonstrated.
- o Two-dimensional relationships are important (physical placement, relative location).
- o Three-dimensional structure is important.
- o Visual art is being studied.

[b]Answer "Y" if:

- o Specific sounds must be presented.
- o Music or oral literature is being studied.
- o Presentation merely in textual form would make the subject difficult for many students to understand.
- o Simultaneous aural narration would be preferable to interrupting visual continuity with caption frames.

[c]Answer "Y" if:

- o Mastery of the instruction will eventually require the recognition or performance of a procedure that is initially unfamiliar to the learner.
- o The subject's manner of movement is important to the recognition or description of it.
- o Slow or fast motion is required to portray changes that ordinarily take place too rapidly or too slowly to be otherwise comprehensible.

[d]Dash means that either "Y" or "N" would give the same result.

[e]Answer "Y," for example, if the subject matter is the learning of certain darkroom techniques, which require only the sense of touch.

[f]None appropriate.

Answer for

29., cont. Learning events indicated by Decision Table A as being in the conceptual domain.

DECISION TABLE B

Conditions: *Would the following be desirable in your learning event?*	Rules *(Read down.)*										
1. Presentation by audial means rather than print?[a]	Y	Y	Y	Y	Y	Y	N	N	N	N	N
2. Print or visuals to accompany audial presentation?[b]	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N
3. Pictures, in addition to alpha-numerics or line graphics?[c]	-	-[d]	N	N	Y		-	-	N	Y	
4. Semimotion?[e]		N	N	Y	Y			N	Y	Y	
5. Full motion?[f]	Y	N	N	N	N		Y	N	N	N	
Actions:											
6. Simplest appropriate media class [x(29) =]	I	II		III		VII	IV	V	VI		VIII
7. Simplest appropriate multimedia category[g] [x(29) =]			VII-VIII		II-III					V-VI	

NOTE: As mentioned in the text, subject matter in the conceptual domain requires only spoken or printed words and symbols for communication. But visual communication means may be desirable. Determining what they are is the purpose of this decision table.

[a] Answer "Y" if:
- Presentation in print only would make the subject difficult for many students to grasp.
- The personal element (more readily conveyed by the spoken word than by print) is important in this learning event.
- An objective of this learning event is to change feelings or attitudes, and the effective use of audial means would help achieve it.

[b] Answer "Y" if:
- This learning event involves concepts and relationships that would be clarified by graphic presentation (charts, graphs, diagrams, etc.).
- The logical relationships or order of items is important enough to warrant having a diagram or outline to refer to throughout the presentation.
- Reading or writing is being taught, or a difficult technology is being introduced, and spoken words should be related to their counterparts in print.

[c] Answer "Y" only if:
- A value concept is to be illustrated by showing its indirect results (e.g., an emotion by facial expression or gait).
- A concept is to be indicated by a concrete symbol (e.g., handshake = friendship; flag = country, patriotism).

[d] If the answer here is "N," a choice of media classes is offered: class II or multimedia category VII-VIII.

[e] Answer "Y" if:
- The information would be more comprehensible by writing words or other symbols in sequence, or by drawing diagrams, e.g., on a chalkboard.
- The motion of pointing would be useful, e.g., for tracing a route on a map.

[f] Answer "Y" if:
- The concrete effects of hidden or abstract processes are to be shown, and motion can make the processes perceptible.
- Animation of diagrams or other symbolic representations is needed to demonstrate the effects of change, either in the symbols themselves (e.g., the movement of letters to teach reading) or in the idea they represent (e.g., animating an organizational chart to show a change in government structure).

[g] For multimedia classes, see Table 2.

events in those categories. In most cases, it will be class V (still-visual), which includes printed matter.

To answer question 29, begin with Decision Table A. Reading the questions in the Conditions column, answer each "Y" or "N" ("Yes" or "No"). The footnotes to the questions give criteria for making the decisions. Then, look over to the Rules column and find the pattern of Y-N answers that corresponds to that for your learning event. In most cases, Action 5 will tell you the number of communication media class that is appropriate for your learning event. That number is to be entered on your response form as the answer for question 29. A pattern of "N" answers to all four questions means that the subject matter of the learning event is in the conceptual domain, and you are directed to Decision Table B, which is read similarly to Decision Table A. Besides specifying class of media, Decision Table B also specifies class of multimedia, where appropriate (see Table 2).

Table 2

CLASSES OF COMMUNICATION MEDIA AND MULTIMEDIA CATEGORIES

Media Classes		*Multimedia Categories*	
I	Audio-motion-visual (e.g., sound film, TV)	I-II	Audio-motion-still-visual (e.g., Norelco's P.I.P., a sound-motion-filmstrip system)[a]
II	Audio-still-visual (e.g., sound slide set)	II-III	Audio-semimotion-still-visual (e.g., telewritevision)
III	Audio-semimotion (e.g., telewriting)		
IV	Motion-visual (e.g., silent film)	IV-V	Motion-still-visual (e.g., Eastman Kodak's MFS-8, a motion-film-strip system)[a]
V	Still-visual (e.g., printed page)		
VI	Semimotion (e.g., teleautograph)	V-VI	Semimotion-still-visual (none at present)[b]
VII	Audio (e.g., audio tape)	VII-VIII	Audio-print (e.g., Audi/Pointer™)
VIII	Print (e.g., teletype)		

[a]The decision to use these categories of communication media depends on data additional to what is provided in the curriculum analysis. Therefore, these categories are not included among the communication media suggested in question 29, Decision Table B. The combination of motion and still pictures in one system, which these categories represent, has an advantage mainly in the cost of *media software* over motion pictures alone. Scenes involving no motion amount to nearly half the length of the average instructional film. Nor do most motion pictures require as many as the standard 24 frames per second for smoothness and realism. Thus, for cost and practicality, these multimedia have much to recommend them.

[b]No example of this category is currently in use, although the Plato IV system is being developed at the University of Illinois, and Telestrator Industries of Chicago has built a variety of electronic devices that will perform this and other multimedia functions. Until such models are operational, the instructional designer should substitute class IV media or multimedia category IV-V when the CAQ designates this category.

PART III

Questions 30 through 33 attempt to establish the level of visual or audial fidelity required if the presentation were to be made by communication media instead of face-to-face. At this point, the user is concerned only with presentations to the student, not with the student's response.

All media classes except VII (audio) and VIII (print) have some visual component (although the print media class is *visible*, it is not considered *visual* in this context); therefore, questions 30, 31, and 32 should be answered if x(29) = any value except VII or VIII.

Question 33, concerning audio fidelity, applies only to the media classes and multimedia categories with sound, and thus should be answered only if x(29) = a value other than IV, V, VI, VIII, or V-VI.

Because some instructional designers may not be familiar with the standard measures of technical quality in such matters as gray scale and definition, some examples of each level are given, based on media that are commonly encountered. The decisions required are fairly gross; it usually will not make much difference if the user chooses a category that is a step too high or too low.

The final version of the CAQ will probably provide a set of criteria to assist the user in each of these decisions, similar to those provided for the decision tables in question 29. At present, the options are merely described by example.

	Answer for all events for which x(29) =	Question	Code
30.	I,II,III,IV,V, VI, II-III,V-VI	What level of color fidelity is required of the visual presentation medium?	
		Black and white (monochrome) pictures will suffice.	x(30) = 1
		Color will be used for coding or emphasis, with no need for realism.	x(30) = 2
		Full color, with an approximation of realism (e.g., quality of color as seen in the average home TV receiver or as reproduced by the less expensive helical scan VTR recorders).	x(30) = 3
		Full and realistic color.	x(30) = 4
31.	I,II,III,IV,V, VI,II-III,V-VI	What level of gray-scale fidelity is required of the visual presentation medium?	
		Choose only if:	
		x(30) = 1. Two tones, simple black and white.	x(31) = 1
		x(30) = 1 or 2. Three to six tones (typical of poster art, average or	

Answer for all events for which x(29) =		Question	Code
		below-average home reception of broadcast television).	x(31) = 2
		x(30) = 1, 2, 3, or 4. A gray scale of 7 to 12 tones (typical of above-average broadcast television reception, average 16-mm or 8-mm film).	x(31) = 3
		x(30) = 1, 2, 3, or 4. Need to discriminate between 13 or more tones (characteristic of photographic prints made from negatives of wide latitude; details are visible simultaneously in highlight and shadow areas).	x(31) = 4
32.	I,II,III,IV,V, VI,II-III,V-VI	What level of definition is required of the visual presentation medium?	
		300 "TV lines" or less. This is the level of definition associated with either color or black and white TV broadcast on an average home receiver.	x(32) = 1
		Between 300 and 600 TV lines. This is the definition expected of a good closed-circuit TV system, video (not R-F) distribution, and display on high-quality monitors (not receivers). Also characteristic of the quality of control-room broadcast TV, 2-in. broadcast standard video tape, or black and white 8-mm film.	x(32) = 2
		Between 600 and 900 TV lines. This is the definition usually associated with 8-mm color film or a high-definition (10 MHz bandwidth) video system.	x(32) = 3
		Over 900 TV lines. This is characteristic of Super-8 color film, 16-mm film, either black and white or color, or a very high-definition, closed-circuit TV system with 18 MHz bandwidth distribution and over 1000 scanning lines.	x(32) = 4
33.	I,II,III,VII, VII-VIII, II-III	What level of audio fidelity is required?	
		Voice-quality audio is sufficient; no need for music or realistic sound.	x(33) = 1
		Audio system should be capable of good music reproduction, e.g., the quality of a typical AM radio broadcast.	x(33) = 2
		High-fidelity, capable of realistic sound, e.g., typical FM radio reception.	x(33) = 3
		Very-high-fidelity, capable of excellent sound realism, e.g., a $2000 stereo system.	x(33) = 4

IV. USE OF THE CAQ TO ANALYZE A COURSE IN BEGINNING PHOTOGRAPHY

This section looks over the shoulder of a hypothetical instructional designer as he analyzes two learning events in a course on beginning photography by means of the CAQ. The course is relatively short, containing only 30 learning events; it could be completed by the average student in about 10 instructional days.[11] Completion of the CAQ for all learning events in the course is shown by the filled-in CAQ response form, Fig. 2. Each line in column j represents a learning event in the course, numbered according to its sequence in the topic, noted in column k. The columns denote CAQ question numbers.

As is evident from the text of the CAQ in Sec. III, not all questions pertain to each learning event. The learning events in this course encountered as few as 18 and as many as 29 of the 33 questions. Here we follow two representative learning events through the analysis. The reader may want to refer back to the text of the CAQ and to Fig. 2 as the discussion proceeds.

LEARNING EVENT 1-1

The instructional designer has described learning event 1-1 (i.e., the first learning event in the first topic) as follows:

> An introductory presentation covering a general orientation to photography as a career field, the study methods that will be used in the course, and an outline of overall course content. Students will not be examined (formally evaluated) for mastery of this material.

The first eight questions (j, k, 1-6) are to be answered for all learning events. In

[11] For a detailed description of this course, see Robert L. Petruschell and Polly Carpenter, *MODIA Applied in the Design and Cost Analysis of an Innovative Air Force Course*, The Rand Corporation, R-1021-PR, November 1972.

j	k	l	2	3	4	5	6	7	8	9a	9b	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	1	35	0	0	0	0	1														25		1	0	12	0	0			0	II	1	3	3	2
1	2	120	0	0	0	0	1														60		1	1	24	0	0			0	V	1	1	1	2
1	3	120	0	0	0	0	11			0	0			4				1	1	10	90		1	0	60	0	0			0	I	1	3	2	2
1	4	75	0	0	0	0	2			0	0			0				1	1	50	50		1	1	60	0	1	0	0	0	V	1	3	2	2
2	1	30	0	0	0	0	2			0	0			0				1	1	50	20		1	0	60	0	0			0	V	1	3	1	2
2	2	120	0	0	0	0	2			0	0			0				1	1	50	100		1	1	60	0	0			0	V	1	3	2	2
2	3	30	0	1	0	0	11			0	0			0				1	1	10	30		1	0	48	0	0			0	IV	1	3	2	2
2	4	150	0	1	1	0	9	0				1	1	2	0			1	1		10	1	1	1	48	0	1	0	0	2	V	1	1	1	2
3	1	35	0	1	1	0	1														30		1	1	12	0	0			1	V	1	1	2	2
3	2	60	0	1	0	0	1														50		1	1	60	0	0			0	V	1	1	2	2
3	3	30	0	1	1	0	1														25		1	1	60	0	0			2	V	1	1	2	2
3	4	30	0	1	0	0	11			0	0			2				1	1	10	25		1	0	60	0	0			0	V	1	4	4	2
3	5	60	0	1	1	0	1														50		1	1	24	0	0			5	II	1	2	2	2
3	6	60	0	1	1	0	1														50		1	1	60	0	0			5	V	1	1	2	2
3	7	120	0	1	0	0	12	0				1	1	2				1	1	5	30	1	1	1	48	0	0			0	V	1	3	2	2
3	8	45	0	1	1	0	2			0	0			0				1	1	5	35		1	1	48	0	0			1	V	1	1	1	2
3	9	340	0	1	1	0	9	0				1	1	2	0			1	1		10	1	1	1	60	0	1	0	0	2	V	1	1	1	2
4	1	15	0	0	0	0	1														15		1	0	48	0	0			0	V	1	2	1	2
4	2	30	0	1	0	0	7	1				1								50	20	1	1	1	48	0	0			0	IV	1	3	2	2
4	3	30	0	1	0	0	11			0	0			4				1	1	10	25		1	0	60	0	0			0	IV	1	3	2	2
4	4	15	0	1	1	0	1														15		1	1	36	0	0			2	V	1	1	2	2
4	5	60	0	1	1	0	9	0				1	1	4	0	2	4	1	1		5	1	1	1	48	0	0			2	V	1	1	1	2
4	6	60	0	1	1	0	9	0				1	1	4	0			1	1		5	1	1	1	48	0	1	0	0	4	V	1	1	1	2
5	1	90	0	1	0	0	1														75		1	1	60	0	0			0	V	1	3	2	2
5	2	30	0	1	0	0	11			0	0			2				1	1	5	20		1	0	60	0	0			0	V	1	3	2	2
5	3	30	0	1	1	0	4	0				1			1							0	1	0	60	0	0			3	V	1	3	2	2
5	4	30	0	1	0	0	6			0										5	15		1	0	60	0	0			0	I	1	2	2	2
5	5	30	0	1	1	0	4	0				0			0						5	1	1	1	60	0	0			4	V	1	2	1	2
5	6	60	0	1	0	0	4	0				1			0						0	0	1	0	60	0	0			0	0	1	1	1	2
5	7	180	0	1	1	0	9	0				0	3	2	0						10		1	0	60	0	1	0	0	1	V	1	1	1	2

Fig. 2—Sample CAQ response form filled in for a course of 30 learning events

j and k, respectively, topic numbers are assigned and learning events are numbered sequentially within their topics.

Question 1 asks the designer to estimate the number of minutes required for the average student in the expected population to achieve the objectives of the learning event, given conventional methods and no time spent waiting for facilities or equipment to become available. For this learning event, the designer visualizes a passive group attending a classroom lecture and decides it would require 35 min; so he marks 35 on the response form; thus, $x(1) = 35$. There is no waiting time in this particular event, of course, since it involves no student practice with facilities or equipment.

Question 2 asks the designer to estimate any additional time required for housekeeping activities. For the sake of simplicity, housekeeping in this course is assumed to be included in the time estimated in question 1 for all events; therefore the answer to question 2 is always 0. In the real world, a separate estimate of time would ordinarily be made in answer to question 2. Actually, since the first learning event here is only a presentation and does not require the use of materials or equipment, no housekeeping time is required anyway.

Question 3 seeks to determine the complexity of the learning event by asking whether mastery of the subject matter requires the integration of several simpler skills or concepts. In this example, the answer is "No" and $x(3) = 0$. Question 4 elicits further information on the difficulty of the subject matter by asking whether the average student in the learner population would find it relatively easy or relatively difficult to master. Here, the designer codes the question as $x(4) = 0$, indicating that he considers it easy.

Question 5 determines whether this learning event is a basic part of the instructional sequence or whether it is designed for a special subset of students, such as those who lack necessary prerequisites or those who have already mastered the subject matter. In this course, all learning events are intended for all students, so the answer is always 0.

Question 6—a key question—asks that the learning event be assigned a number from 1 to 12 identifying the particular type and category of instruction it represents. Since learning event 1-1 requires no student performance, it is clearly Type I instruction (see Table 1); because it requires no special facilities or equipment, it is coded category 1.

Many of the following questions are answered or not answered according to the instructional category number, so the designer scans the list in the left column of the CAQ, looking for "1." He finds it in question 19, which asks for an estimate of the time required only for the actual presentation or demonstration in the event. For this learning event, the designer enters 25 min, indicating that he expects 10 of the 35 min estimated in question 1 to be devoted to introductory remarks, questions by the students, etc. This question seeks to determine the duration of the presentation, so that if a communication medium is to be used, the amount of media software required can be estimated.

As question 20 does not apply to category-1 instruction, the designer proceeds to question 21, which begins a set of questions to be answered for all learning events.

Question 21 asks whether this is to be considered a scheduled or **unscheduled** learning event. The designer decides x(21) = 1, indicating that the event is scheduled in time and place. Question 22 asks whether students will be formally examined on the material. Because this learning event is an introductory presentation, the designer enters x(22) = 0. That indicates that the objectives of this first event are intended to help the learners master the material in the second learning event, which will be formally evaluated.[12] Question 22 is important in determining the requirements of the evaluation sessions that cover this portion of the course.

Question 23 relates to the possible use of communication media for the presentation, and asks how frequently its subject matter would ordinarily be revised. Because learning event 1-1 relates to the entire course content, revisions would occur fairly frequently. The designer estimates 12 months between revisions, hence x(23) = 12.

Question 24 determines if the event contains classified information. The course on basic photography contains no such information, so the entire column is coded 0. Question 25 asks whether this event marks the end of a major course section; since it does not, x(25) = 0. This information is required to schedule any review or examination sessions.

Questions 26 and 27 are to be answered only if x(25) = 1; they ask for estimates of the number of [wash-backs] or dropouts expected. Since x(25) = 0, these questions do not apply.

Question 28 applies to all learning events. It asks for an estimate of the percentage of students that are apt to need remedial instruction before being able to master the subject matter in the learning event. Since this event was previously classed as easy (x(4) = 0), and since it is only introductory, no remedial instruction is expected, and x(28) = 0.

The designer then moves on to Part II of the CAQ, which concerns selection of the most appropriate class of communication media. (The decision whether or not to actually use communication media will be made later in setting the strategy.) If the strategy specifies face-to-face presentation, for example, this information will help select the appropriate instructional aids.

Question 29 is actually a series of questions, presented as Decision Tables A and B (see pp. 17 and 18). Beginning with Decision Table A, the designer answers questions about the presentational needs of the learning event, referring to the criteria in the footnotes. The pattern of Yes-No answers on the table that corresponds to his pattern of answers leads to the designation of the simplest appropriate communication media class.

In the present case, the designer's pattern of answers corresponds to the pattern that directs him to Decision Table B, indicating that the subject matter in this learning event falls in the conceptual rather than the perceptual domain.

Now at Decision Table B, the designer considers the first question about the desirability of presentation by audial means rather than print. Referring to the criteria in the footnotes, he decides that the first criterion applies: many of his

[12] Such objectives are often termed *enabling objectives.*

students would understand the information better if they heard it rather than read it. He records a "Y."

The next question asks about the desirability of print or other visuals to accompany the audial presentation. Since the designer is thinking of using a list of lesson topics for the course, a list of careers in which photography is used as a professional tool, and perhaps some pictures of aerial photographers at work (to help the student form an image of himself as an Air Force photographer), he decides that visual means would be desirable[13] and enters a "Y."

The next question asks whether pictures would be desirable in addition to print and black-white graphics. Thinking of the photos of aerial photographers, he answers "Y."

The fourth question asks about the desirability of motion in the visuals. Our designer can think of no reason for motion and enters "N." Similarly, the last question, about the desirability of semimotion, elicits a "N"; he can think of no purpose for "pointing" or "buildup" (writing or drawing), the two basic kinds of semimotion. His pattern of three Y's followed by two N's corresponds to the pattern that designates class II as the simplest appropriate media class to use for this learning event. He enters a II for x(29) on the response form.

Then, he begins Part III of the CAQ. In response to question 30, "What level of color fidelity is required?" the planner decides that black and white will suffice, and answers x(30) = 1. In response to question 31, "What level of gray-scale fidelity is required?" the planner decides that he needs the tonal quality of good television or film presentation and answers x(31) = 3. He might have needed only two tones, black and white, were it not for the pictures of aerial photographers at work.

Question 32 asks for the necessary level of definition. The designer believes that the average home TV reception is not sharp enough; better definition is required to show ground and cloud details in the photograph, to make it clear that the photographer is in an airplane. He thus marks x(32) = 3, the level of definition of a high-quality television system. Finally, in answer to the last question, which asks for audio fidelity requirements, the planner enters x(33) = 2—the level of quality of good AM radio reception. That is sufficient because the only important sound will be the instructor's voice.

LEARNING EVENT 4-5

As the first learning event followed through the CAQ was Type I instruction, category 1, we did not encounter all the questions in the questionnaire. To illustrate how questions that apply to other instructional categories might be answered, we chose learning event 4-5 (the fourth learning event of the fifth topic) to take through Part I of the CAQ (answering the other parts of the CAQ will not vary as much with

[13] The affective objective—the student's formation of a positive future self-image—could have led the designer to believe that visual means were *required*, and to select a different rule in Decision Table A. In either case, however, communication media class II would have been indicated.

the type of instruction). The objectives of learning event 4-5 were described as follows:

> Each student takes two pictures and develops the exposed cut film. Here he will get a chance to put into practice the process of developing film that has been demonstrated and explained to him. Given a familiar 4 x 5 press camera and familiar film stock, after mastery of this event on an exam he will be able to properly expose and correctly develop a negative under similar conditions to the satisfaction of his instructor.[14]

Learning event 4-5 is estimated to require 60 min to complete and to be both relatively complex and relatively difficult to master. In question 6 it is classified as category 9 instruction because it is the pure performance of individual skills that requires special equipment or facilities.

The next question encountered for a category 9 learning event is question 7, which asks whether speed of performance is an objective of the event. For this event, it is not; hence $x(7) = 0$.

Question 10 asks if an instructor must be present to provide the student with knowledge of correct responses, and the designer answers "Yes." That automatically determines the answer to question 11, which asks what level of supervision is necessary to prevent injury to either the student or the equipment. The designer realizes that he must enter "1" (supervision by an instructor) if he has entered "1" for the previous question, because if the instructor must be present to let the student know how he is doing, he will be available for safety supervision as well.

Question 12 asks what special area is required. Since the objectives say nothing about where the two photographs are to be taken, it is a minor consideration. The designer, thinking only of the place needed to develop the photographs, codes $x(12) = 4$, a small laboratory—in this case a darkroom.

Question 13 asks if student mastery of the skill involved can be diagnosed by having the student make selected responses. In this case the answer is "No," so $x(13) = 0$. Questions 14 and 15 are answered only if $x(13) = 0$. Question 14 asks the nature of the constructed response required. Since the student is actually producing something, rather than using verbal or graphic means to express a thought or solve a problem, the planner codes $x(14) = 2$, a student product.

Question 15 asks what means would be most appropriate for recording students' constructed responses. A number of specific communication media are listed that can (1) express and record information by students (e.g., paper and pencil); (2) keep a record of student performance that would otherwise be lost (e.g., a recording of the pronunciation of foreign words); or (3) actually constitute a student product (e.g., a student film). A final category is available if the product is to be made of materials other than communication media (e.g., assembly of an electronic circuit). In this

[14] Note that this criterion for an acceptable level of skill—"satisfaction of the instructor"—is not an empirical measure. That reflects a problem encountered in specifying most constructed responses. "Correctness" has nothing to do with "artistry" in a photograph, for example. The best way to determine the attainment of artistic quality is to set up a board of review and average out the subjective judgments of a number of experts. Since that is impractical in the present course, the instructor's judgment has to suffice as the criterion.

learning event, still photography can serve at least two purposes, and because the student must expose and develop a photographic negative, the designer answers $x(15) = 4$.

Question 16 asks whether special equipment is required for the instructional presentation. Equipment that might be necessary if a presentation were to be transmitted or recorded is not considered. In this case, cameras and darkroom equipment are needed for the instruction, so the answer is "Yes," $x(16) = 1$. Question 17, to be answered only if $x(16) = 1$, asks if the special equipment is already on hand. In this case, we assume that the designer has all the necessary facilities and equipment, so $x(17) = 1$, "Yes."

Question 19 asks for an estimate of the time required, in this case, to give problems and directions. The designer estimates 5 min, so $x(19) = 5$. The last question in Part I that pertains to instructional category 9 is question 20. It asks whether students will require special materials. Thinking of the raw film that will be exposed, the designer replies "Yes," and $x(20) = 1$.

V. TESTING THE CAQ

The task that lies ahead is to test the CAQ in use by actual instructional designers to determine if it elicits the information it was designed to obtain. If it does not, the phrasing of the questions or the format of the questionnaire will have to be modified. Empirical evaluation will inform us how long it takes an instructional designer to analyze a given number of learning events. We can also get a good idea of how much assistance or insight the designer gains merely by using this tool in its manual form. We have not attempted to design in detail a field evaluation program. These comments are intended only to suggest some useful components of such a program.

Although the CAQ is designed to be used by an instructional designer without assistance, testing of the CAQ must be done in an interview format, by someone familiar with the questionnaire and the intent of each question. Failure to elicit the desired information can thus be immediately detected and notes made to guide revision.

The CAQ has already benefited from one such test. The team of three persons who had worked on the questionnaire interviewed an instructional designer for 2 or 3 days. Each question was asked verbally and the respondent's answer and any discussion were recorded. First, an existing course was analyzed and a number of its learning events were taken through the CAQ. Then, the designer was asked to give his imagination free rein and think of the course as he would *like* to teach it, thus making it an entirely new course.

This procedure, although crude, proved extremely valuable. As a result, the questionnaire was thoroughly revised; questions were added, subtracted, and rewritten in accordance with our findings.

Future testing, however, will have to be more carefully designed and controlled. More than one designer should be interviewed, preferably designers planning different kinds of courses and designers with various educational backgrounds and varying amounts of experience. Interest in instructional innovation would be another important variable to have represented in the testing, as well as prior experience in designing instruction using communication media.

The questionnaire is designed to be applicable to any kind of instruction at any educational level. Thus, the CAQ should be tested with a variety of courses, to

determine if the questions are universally applicable. Since the evaluation would not attempt quantitative estimates, the size of the sample would not be a critical factor.

Table 3 lists some of the important variables that should be considered and some of the values pertaining to them. Although the total number of combinations of all the values for all the variables listed could amount to several hundred, it should not be necessary to select more than 10 courses and their designers to satisfactorily validate the CAQ. If necessary, the process could be repeated with ensuing revisions. To reduce the effects of inadvertent bias in the interviewer, at least two interviewers should be used.

A possible procedure might be, first, to test the directions and format of the questionnaire by asking the designer to read and answer silently, say, the first five or six questions. Any difficulties encountered could be discussed. Then, the remainder of the questionnaire could be answered and discussed orally.

Table 3

VARIABLES TO BE INCLUDED IN EMPIRICAL TESTING OF CAQ

Variable	Values
Courses	
Educational level	Elementary; secondary; technical training; post-secondary
Course level	Elementary or advanced; basic or specialized
Type of instruction	Theory; practice
Inception	New course; redesign of existing course
Instructional Designers	
Sex	Male; female
Formal training in instructional design	None; some; a lot
Educational attainment	Secondary school only; college; graduate study
Familiarity with the use of communication media in instruction	None; conventional instructional aids only; print media; audial, visual, or audio-visual media
Attitude toward innovation in instruction	Conservative; liberal

Since in Part I any one learning event would be subjected only to the questions that apply to its particular category of instruction, different kinds of learning events should be analyzed until each question has been encountered at least once. Since the purpose is to test the questions, not to analyze a curriculum, the testing procedure could skim through a course, analyzing those learning events that would be likely to involve questions that had not yet been asked. If it became obvious that a course would not involve several categories of instruction, and hence that not all questions would be encountered, special courses could be sought to test out the remaining questions.

For each course, approximately 20 learning events should be analyzed. Some questions may apply to all of them; others to only a few. One interview may take as long as two or three hours. Although the time required for the interview will not be a reliable guide to the time required for the solitary instructional designer to go through the CAQ, it may be possible, at least during the later interviews, to estimate that time. Courses should be chosen that are actually being designed or redesigned. Preliminaries such as the formation of the curriculum, the ordering of learning objectives, and the subdivision of the course into learning events, must have been done before the evaluation interview. Where there is a choice, it would be wise to select designers who are articulate, or at least talkative, in the hope of obtaining a better resolution of any problems that might arise in interpreting the interview results.

GLOSSARY

Affective domain: Subject matter pertaining to feelings, emotions, attitudes.

Cognitive domain: Subject matter pertaining to the recognition or recall of knowledge and the development of intellectual capabilities and skills.

Communication medium: A means of communicating that is self-contained, i.e., it can convey a message without the message sender's being at the point of reception. Audiovisual materials, such as flip charts, mock-ups, and "Vu-graphs," are communication *aids,* not communication media. There are eight classes of communication media, according to the author's taxonomy (see inside front cover).

Constructed response: A student performance or product, e.g., speaking, writing, drawing, gesturing, using a tool, operating a machine, making something. Compare **selected response**.

Conventional instruction: Classroom and laboratory group methods in which lecture, oral quiz, guided discussion, drill, and the use of texts and workbooks predominate. Includes demonstrations by an instructor.

Discussion: (1) A fairly informal session set aside after a segment of basic instruction to answer students' questions or to stimulate student discussion of the subject matter covered. Not considered a separate learning event, but taken into account in the MODIA process on the basis of stated strategy. (2) A segment of instruction to teach students to converse and interact in a group. Considered a learning event of Type II instruction (team skills).

Drill: An activity intended to help the student learn a relatively simple skill by repeated, fairly mechanical response to a stimulus. The stimulus is usually external, as in typing from a text or repeating foreign words after a model to practice pronunciation. The student provides his own stimuli in most independent study. Compare **practice**.

Evaluation: The measurement or assessment of student achievement; may be formal or informal. Common means are the quiz, performance test, final examina-

tion. Used to measure students' progress and sometimes to regulate their advancement in a course of study. Evaluation segments are not considered separate learning events in the curriculum analysis. The MODIA process automatically accounts for them on the basis of stated instructional strategy.

Follow-me instruction: The step-by-step demonstration of procedures, which students copy, or student practice following step-by-step directions. May occur in either Type II or Type III instruction; applies only to individual skills.

Formal evaluation: An examination.

Housekeeping: Giving assignments or announcements, classroom management, cleanup, etc. The time required for housekeeping will often depend on the activities carried out during the class session; it is usually greatest with Type III instruction. Not considered a separate learning event in the curriculum analysis.

Independent study: Study by individual students or groups of students at a time of their own choosing, at home or at school, with no instructor or monitor present. Synonym for **unscheduled instruction**.

Instructional aid: Either a communication aid used by an instructor (e.g., flip charts) or a learner's aid, such as an actual or simulated object being studied.

Learning event: A basic segment of homogeneous instruction. Does not include question-and-answer sessions, discussions (in the first sense), scoring of deskwork or homework in class, examinations, housekeeping, coffee breaks, or transportation.

Materials: See **media software**.

Media software: Recorded program materials, e.g., films, tapes, books, discs, etc., containing messages. Used as instructional or communication aids.

Performance: Student activity in Type II or Type III instruction, in which the student learns how to do something, such as a skill, not simply absorbs ideas or information. Student responses in Type I instruction (answering questions, filling in blanks in a workbook, etc.) are not considered performance.

Performance model: Demonstration of a skill that a learner is expected to master.

Practice: Student performance in learning relatively complex skills, as distinguished from **drill**, performance in learning relatively simple skills. Practice is less repetitive and automatic than drill; a student may practice a complex skill, such as troubleshooting or writing a business letter, only a few times during the course of study and may have a slightly different assignment each time. As regards practice, the presentation of stimuli is less important than for drill, but the demonstration of the skills to be learned is more important.

Presentation: Any communication to the student. Includes transmitting facts or concepts, demonstrations, giving directions, supplying stimuli for drill, describing problems to be solved.

Print: A way of representing information using symbols such as alphanumeric characters, pictographs, logograms, ideograms, hieroglyphics, and handwriting. Does not include line graphics or pictures.

Psychomotor skills: Skills requiring muscular movements, usually manipulative, including hand-eye coordination, pronunciation, handwriting, and using tools. Because most such skills require cognitive support (are more than automatic motor responses), we use the term psychomotor to refer to all motor skills.

Question-and-answer session: A period for the informal answering of students' questions or discussion (is a synonym for **discussion** in the first sense). Does not include questions answered during the course of instruction. Not considered a separate learning event in the curriculum analysis; automatically taken into account in the MODIA process on the basis of stated strategy.

Remedial instruction: Instruction intended to assist students who have failed to master a particular learning event. Does not include sessions to review or make up work.

Review: An abbreviated version of earlier instruction intended to refresh the learner's memory or skill in preparation for an examination. Such sessions are not considered separate learning events in the curriculum analysis; the MODIA process automatically accounts for them on the basis of stated strategy.

Scoring deskwork: Scheduled instructional time set aside for evaluation of a student's work (usually of the **selected response** type) by the student himself or by another student. Such sessions are not considered learning events in the curriculum analysis. MODIA automatically accounts for them on the basis of stated strategy.

Selected response: A means of evaluation in which the student selects one answer from a choice of two or more, or places a list of items in the correct order. Multiple-choice and true-false questions, and matching and ordering tests are common forms. Compare **constructed response**.

Semimotion: "Buildup" or "pointing" or both. Buildup is the accretion of lines or symbols, as in writing or drawing; pointing is the indication of points, areas, or routes on a picture or line graphic by the motion of a pointer, spot, or symbol. "Pop-in" of labels, lines, etc., is not semimotion and can be done by a sequence of two or more still pictures.

Special equipment: Equipment or tools that students must use other than the traditional paper and pencil, drawing instruments, slide rules, or other small

implements. Such equipment (1) is so expensive and fragile (such as precision measuring instruments) or dangerous (such as corrosive acids) that student use must be supervised, or (2) requires special facilities to be used. Projectors, playback devices, and the like, which are used for communicating with the student, are not included unless they themselves are the subject of study.

Special facilities: Areas that are different from a conventional classroom, such as workshops, laboratories, hangars, playing fields, and gymnasiums.

Team: Two or more persons who must work together, e.g., participants in a two-handed game or people using a transit and chain to determine the placement of a survey marker. People working individually in a class do not constitute a team.

Topic: A coherent set of ideas or skills that the student masters as a unit of subject matter in a course and that can serve as the subject of a formal evaluation. Can span several class sessions or can be part of a single class session.

Unscheduled instruction: See **independent study**.

Wash back: To cause a student to repeat a segment of instruction, usually by placing him in a group of less advanced students.